Australian Bureau of Statistics

2051.0 - Australian Census Analytic Program: Forecasting Births, 2006

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Summary

About this Release

This paper describes a new methodology for the estimation of the future number of births by increasing the number of demographic parameters incorporated in the estimation model. Using data from Australian Censuses of Population and Housing (1981 to 2006), the authors demonstrate the increased accuracy gained in the short-term projection of births through the inclusion of parameters such as the timing of first birth, parity, and duration since previous birth to the conventional model which uses mother's age only. This analysis was undertaken as part of the 2001 and 2006 Australian Census Analytic Program (ACAP).

About this issue (Feature Article)

ABOUT THIS ISSUE

This paper has been produced as a part of the Australian Census Analytic Program (ACAP), in conjunction with the Australian Bureau of Statistics (ABS) Demography Program.

The Australian Census Analytic Program is a collaborative venture between the ABS and several of Australia's leading academics and social science researchers. The program is designed to demonstrate the power of Census data, whether used in isolation or when combined with other sources. Each research project conducted under ACAP involves detailed analysis of data from either the 2001 or 2006 Censuses, and significantly advances our understanding of Australia's social, cultural and economic environment. This research project included an analysis of Census data from 1981, 1986, 1991, 1996, 2001 and 2006 Censuses.

An unprecedented level of collaboration between the ABS and the research community has led to the publication of important but previously unrevealed information about Australian society. Much of the research undertaken can lead towards practical policy development.

The authors of this paper are Professor Peter McDonald (Director, Australian Demographic and Social Research Institute, The Australian National University) and Dr. Rebecca Kippen (Future Fellow, Centre for Health and Society, University of Melbourne).

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Forecasting Births (Feature Article)

FEATURE ARTICLE: FORECASTING BIRTHS

By Professor Peter McDonald (1) and Dr. Rebecca Kippen (2)

INTRODUCTION

A great deal of private and public expenditure is contingent upon the future number of births. In the short term, there are the costs and labour involved in the provision of pre-natal, maternity and post-natal services. Later, the number of births affects demand for early childhood education and care, then entries to primary school, secondary school and tertiary institutions. After 20 years or so, the number of births affects the number of new entrants to the labour force.

For age-related services at older ages, there is a great deal of time to plan for the future and the future is relatively well defined by the current age distribution of the population. For child-related services, however, there is little time to plan and to adjust to movements in the annual number of births. Most child-related services are also relatively 'lumpy' in that they come in large blocks like schools or universities. It is therefore vital that countries and regions are able to forecast the future number of births with accuracy.

FORECASTING BIRTHS

In most advanced countries over the past 50 years, statistical agencies have performed poorly in estimating the future number of births (Wilson et al., 2010). Some national statistical organisations, such as the Australian Bureau of Statistics (ABS), do not even attempt to undertake forecasting and instead produce a series of projections which are illustrations of change if certain assumptions on fertility prevail. These projections are not predictions or forecasts. However, with that being said, there are several options potentially available to national statistical organisations to improve births projections. One possible approach is to undertake stochastic projections that provide estimates of the likely range of error of the projected numbers of births. Where this has been done for Australia (Wilson et al., 2010), the range of possible estimates is so wide that policy makers would still be required to make a stab in the dark in estimating future service needs for children. A second approach, the one suggested in this report, is to develop a more sophisticated approach to the measurement of fertility through an increase in the demographic parameters that are used in the projection of births.

CONVENTIONAL METHOD

The conventional method used for the projection of births employs just one parameter as a predictor of the likelihood that a woman will give birth, her age. Rates of birth at each age are 'projected' forward into the future and they are applied to the estimated future numbers of women at each age. Generally, the future level of age-specific birth rates is projected from past trends, or the opinions of experts are obtained. Much of this estimation revolves around the future course of a single summary measure, the Total Fertility Rate (TFR), which is the sum of the age-specific fertility rates in a given year.

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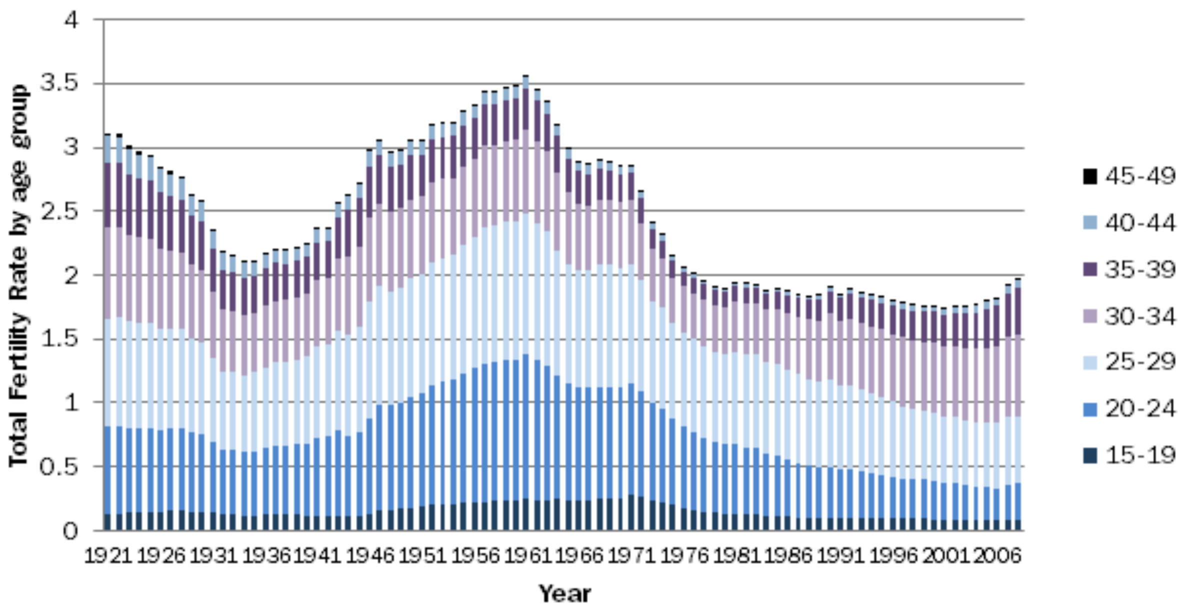
Total Fertility Rate

The Total Fertility Rate (TFR) can be interpreted as the average number of births that a group of women would have across their life times if they experienced the age-specific fertility rates as measured at each age in one calendar year. This is what demographers call a 'synthetic' measure. It is not the real or actual experience of any group of women; it is a synthetically constructed experience based on the assumption that women have the fertility rates of the current calendar year throughout their life time (or, more precisely, between the ages of 15 and 50).

Figure 1 shows the movements in the Australian TFR from 1921 to 2009. It also shows how the TFR is the sum of the age-specific fertility rates in each year. The figure shows how fertility fell to low levels during the 1930s, but then rose again to reach a peak in 1961. For the years 1946 to 1971, the TFR was above 2.8 births per woman; this was the post-war baby-boom. Fertility rates then fell precipitously in the 1970s, falling to a low point of 1.9 by 1980. In more recent times, the TFR trended downwards at a relatively constant rate between 1992 and 2001 and it remained low until 2003.

Figure 1. The Total Fertility Rate, Australia, 1921-2008, shown as the sum of five-year age-specific fertility rates



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Projections of fertility made at this time assumed the TFR would fall even further (ABS, 2003). A program of school closures began in most states and territories, and it was assumed that the then existing maternity services would be adequate. In contrast, a rise in fertility began in 2004 that was sustained through to 2009. By 2008, the TFR was at its highest point in 30 years. In the six years from 2004 to 2009, there have been 152,000 more births than there would have been if the number of births had remained constant at the 2003 level. This is equivalent to over 250 primary schools each with 600 students.

The TFR is a summary measure of the annual incidence of births. As such, it can be affected by numerous factors such as changes in economic conditions (employment, the cost of housing, the business cycle), changes in government support for families with children (taxes and transfers, child care, etc.) and changes in the composition of the population (by relationship status, education, religion, ethnicity, etc.). These factors are usually considered in very broad terms when projections of fertility are undertaken.

However, when fertility rates are low, the main factor that affects the **annual** incidence of births is changes in the timing of births, especially the ages at which successive cohorts of women

have their first births, and this is rarely considered in making projections of fertility. As a simple illustration of this, in Figure 1, the correlation between the TFR in any calendar year and the fertility rate below age 25 years in the same calendar year is 0.92.

Age at first birth

The cumulated first birth rates to given ages for Australian birth cohorts from 1950 to 1984 are shown in Figure 2. The rates are shown relative to those for the 1960 birth cohort. Cohorts born in the 1950s had higher cumulated first birth rates at each age than did the 1960 birth cohort. In other words, they had their first births at earlier ages than those born in 1960. However, cohorts born after 1960 have had their first births at later and later ages. The difference across cohorts is at its maximum at around ages 27 and 28. Across these cohorts, there has been a considerable shift from having the first birth before ages 27—28 to having it from ages 27—28 onwards.

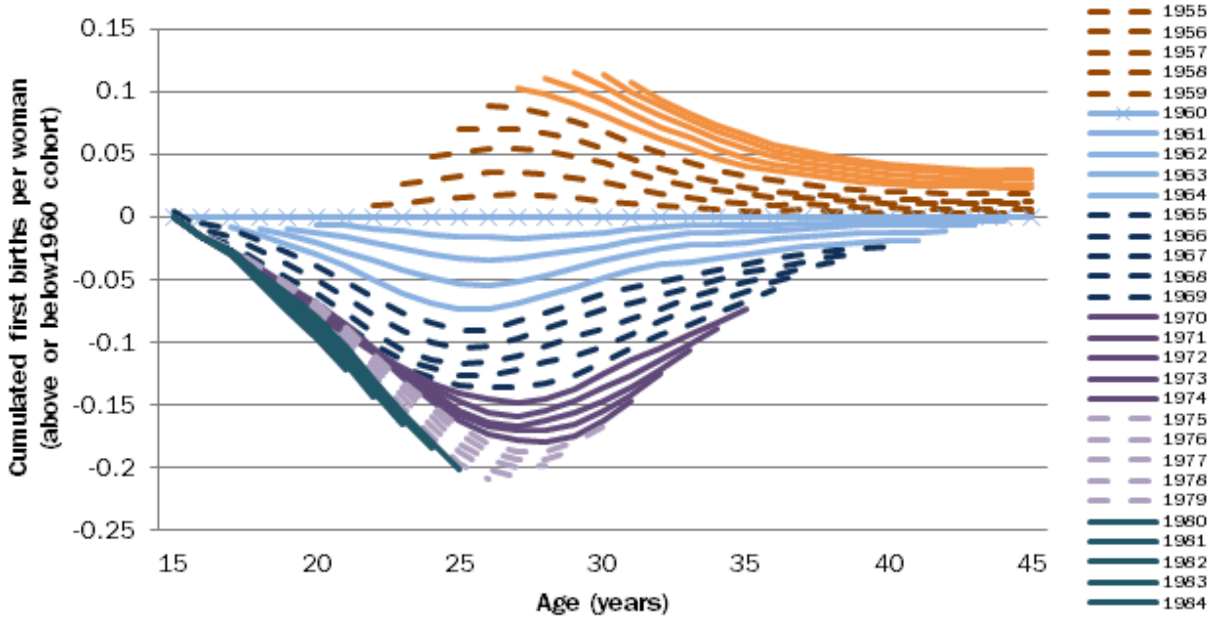

Figure 2: Cumulated first birth rates to given ages for Australian birth cohorts from 1950 to 1984 relative to those for the 1960 cohort (1960 = 0)

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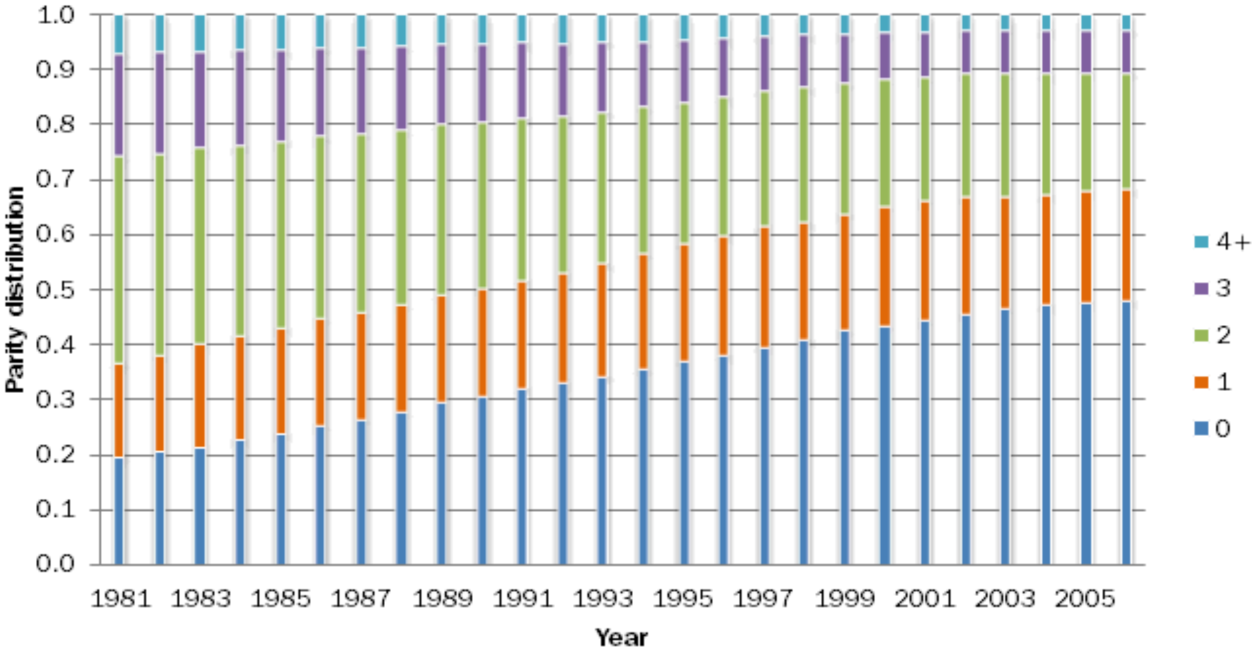
Figure 3 shows this trend in a different way. It shows the distribution of the number of children born to women reaching age 30 in a given year. The proportion having no children rises linearly from 20 per cent for those reaching age 30 in 1981, to 46 per cent for those reaching age 30 in 2001, the year that the TFR hit its lowest point. Implicitly, projections of fertility that were made around 2003 assumed that this upward trend in age at first birth for cohorts would continue. However, as is evident from Figure 3, the trend levelled off from around 2001 onwards. Figure 1 shows that, in the period from 1992 to 2001, the TFR had fallen because the fall in fertility rates for women aged less than 30 (due to later first births) was larger than the rise in fertility rates at ages above 30. From 2001 onwards, Figure 1 also shows that this situation reversed and the TFR rose. To summarise, the TFR has risen in recent years because women at older ages have been having the births that had been delayed in the past while women at younger ages have ceased delaying their births any further than earlier cohorts did.

Figure 3. The distribution of the number of children ever born to women reaching age 30 in the given year, 1981 to 2006



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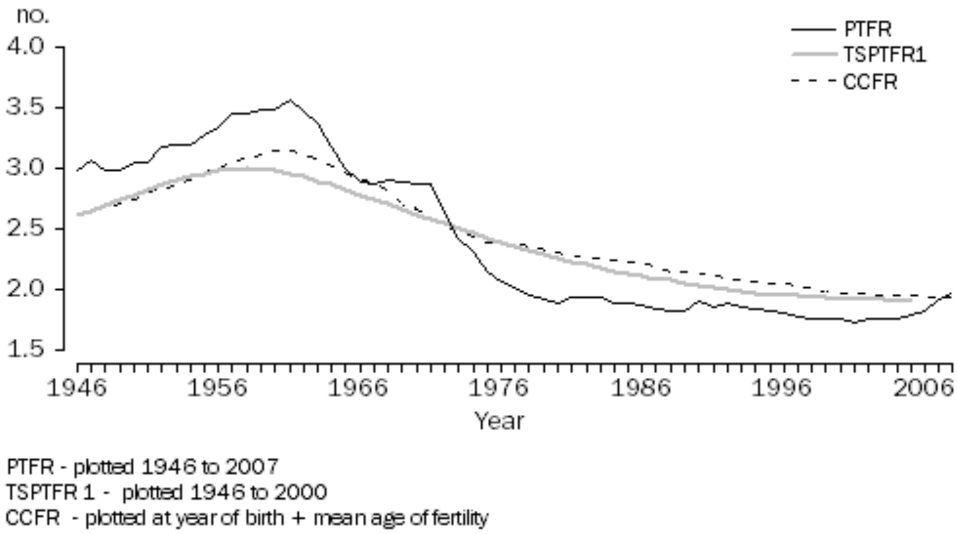
Finally, Figure 4 shows a summary of how changes in the timing of births have affected the Australian TFR over a long period of time. Three lines are plotted:

1. The Total Fertility Rate (as shown in Figure 1), labeled PTFR;
2. A measure, Tempo Standardised Period Total Fertility Rate (TSPTFR1), which removes the effects of timing changes from the trend in the TFR; and,
3. Completed Cohort Fertility Rate (CCFR), the actual average completed number of children born to cohorts of Australian women, plotted in the year equivalent to their year of birth plus their mean age at childbearing.

Figure 4: The Total Fertility Rate (PTFR), Tempo Standardised Period Total Fertility Rate (TSPTFR 1), and Completed Cohort Fertility Rate (CCFR)



The trends for the second and third measures are very similar, suggesting that the

standardised measure (TSPTFR1) provides a very reliable measure of the 'quantum' of fertility, or the underlying level of fertility. The impact of timing changes on the TFR is indicated by the difference between PTFR and TSPTFR1. Our results show that the post-war history of fertility in Australia can be divided into two periods: 1946—1972 and 1973—2007. In the first period (26 years), changes in the timing of fertility contributed to a higher TFR. Across the whole of this period, 61% of the higher fertility rates (relative to 1946) was due to earlier childbearing, while the remainder (39%), was due to increases in the quantum of childbearing.

In the second period (34 years), changes in the timing of fertility contributed to a lower TFR. In this period, 33% of the lower fertility rates (relative to 1973) was due to later childbearing and 67% to a lower quantum. We also concluded that the second period has now ended as the tempo effect on the 2007 PTFR has fallen to zero.

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PROJECTING THE TIMING OF BIRTHS

The above analysis has shown the extent to which the annual incidence of births is affected or distorted by changes in the timing of births. However, it is this annual distorted incidence rate that produces the annual number of births. It is useful to know the trend in the underlying quantum of births (how many births women are having across their lifetimes) but to project annual births we also need to project the timing of these births. Thus, the next step in the analysis is to define a way by which this can be done.

The first point to be made is that changes in the timing of births are driven almost entirely by changes in the timing of the first birth. To a very large extent, as we show below, a woman's later births follow in a fairly regular way given the age at her first birth. This means that, in addition to the women's age, we should project births on the basis of the number of births that a woman has had already (her parity). Furthermore, again as we show below, the time since the last birth has a considerable bearing on whether or not a woman has a birth in a given year. This is because we can normally expect fairly regular patterns for the intervals between successive births.

PROJECTING THE ANNUAL NUMBER OF BIRTHS

On these assumptions, we set out to create a database for Australia that provided estimates of both births and the population of women by three characteristics measured simultaneously: age, parity and duration since previous birth. We require these estimates in great detail: by single years of age of the woman, by single parity (0, 1, 2, 3 etc) and single year of time since the previous birth (zero years, one year, two years and so on). Our approach was to use the Australian Censuses to derive these estimates. The methodology is described in Appendix 2 (Using Census data to create a detailed database for fertility analysis). Having obtained these estimates, we were then able to calculate age-parity-duration specific fertility rates. These rates can also be summed to a total fertility rate which is known in the literature as the Parity-Age-Duration TFR (Rallu and Toulemon, 1994).

The comparison of PADTFR and TFR is shown in Figure 5 for the years, 1990 to 2005. It is important to remember that these two measures are two ways of measuring the same thing: the annual incidence of births. The difference is that one takes account only of the ages of women (TFR) while the other, in addition to age, considers both parity and duration since the previous birth. Figure 5 shows that PADTFR was considerably higher than TFR in 1990 but fell faster than TFR during the 1990s so that the two measures were equal by 2002. They have remained essentially equal through to 2005. The two measures will be equal if the addition of parity and duration since the last birth is providing no additional impact beyond the effects of age. On the basis of observations made later in the report, this would occur if the cohort age-specific first birth rates had stabilised, as has already been argued. We argue, therefore, that

Australian fertility has entered a new period of relative stability across cohorts. However, there is no guarantee that this situation will continue. New patterns of the timing of the first birth may emerge in the future.

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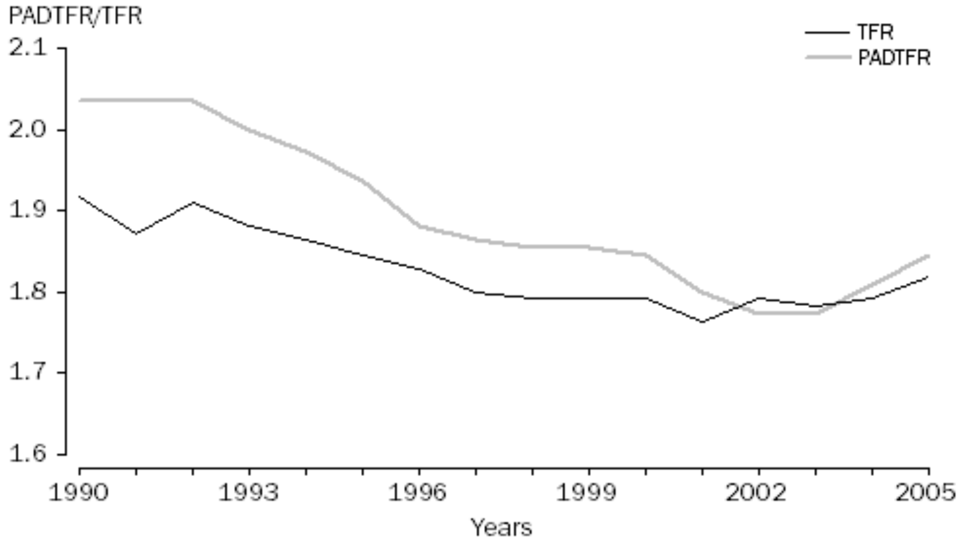
Figure 5: The Age-Based Total Fertility Rate (TFR) and the Parity-Age-Duration TFR (PADTFR), Australia **-** 1990 to 2005



The most important finding from our research database is that for second and higher order births, the age-parity-duration specific birth rates have remained almost constant for over 20 years. This relative stability is indicated for the years 2001 to 2005 in the 15 figures shown in Appendix 1 (Charts of Age-Parity-Duration specific birth rates, 2001—2005). This is important because it means that, if it is assumed that this level of constancy will continue (a strong assumption), projection of future birth rates becomes only a matter of projecting age-specific first birth rates for cohorts.

The methodology was tested on Census data from the years, 2001 to 2006. Using information contained in the database up to the year 2000, births were projected forward to 2006 and compared with the actual outcomes. In these projections, it was assumed that trends in the probability of first birth would follow the trend in these probabilities in the previous five years (1996—2000). Then, we assume that all other transitions remain constant at their most recent value as indicated in the charts in Appendix 1. Importantly, for the population at risk of these birth rates, we use from our database the population of women classified simultaneously by age, parity and duration since the previous birth. Taking account of this more detailed population structure is an important aspect of the methodology.

Figure 6 shows the actual age-specific fertility rates for the years, 2002 and 2006, compared with their projected values. The actual and the projected results are very close. Figure 7 shows the actual and the projected TFR for the years, 2000—2006 using the McDonald-Kippen method. Again, the two are quite close. Indeed, the projection was able to predict the turning point in the Total Fertility Rate that actually occurred. It should be recalled that official projections made around 2003 projected a continuation of the downward trend in the Total Fertility Rate (Commonwealth of Australia, 2002; ABS, 2003). It is evident, at least in this one test, that the method that we propose performs considerably better than the simpler approaches used by official agencies. The error in the number of births projected for Australia from 2004 onwards would have been substantially avoided.

Given that many of the services and infrastructure used by the community, such as maternity services, early childhood facilities, and schools, are directly affected by the annual number of births, it is important that the number of future births can be more accurately forecast, or more

realistically projected. Traditional methods used for the projection of births only take into account a woman's age through the use of the assumed TFR as a predictor of measuring future fertility. This article has shown that the McDonald-Kippen method of forecasting births, which incorporates age, parity and duration since last birth, produced a result that was very close to actual birth rates for 2002 and 2006. It is proposed that the findings from the present study be considered by national statistical organisations to improve the projection of births, which could ultimately lead to improved population projections into the future.

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Figure 6: Actual age-specific fertility rates in 2002 and 2006 compared with those projected using the McDonald-Kippen method

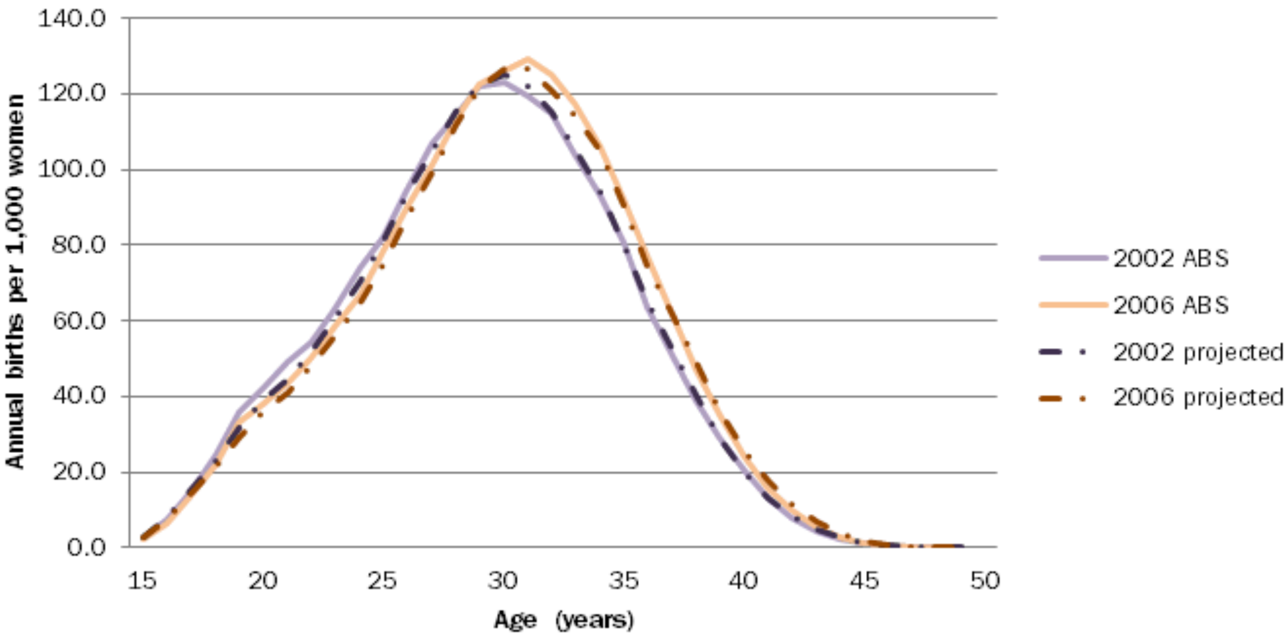
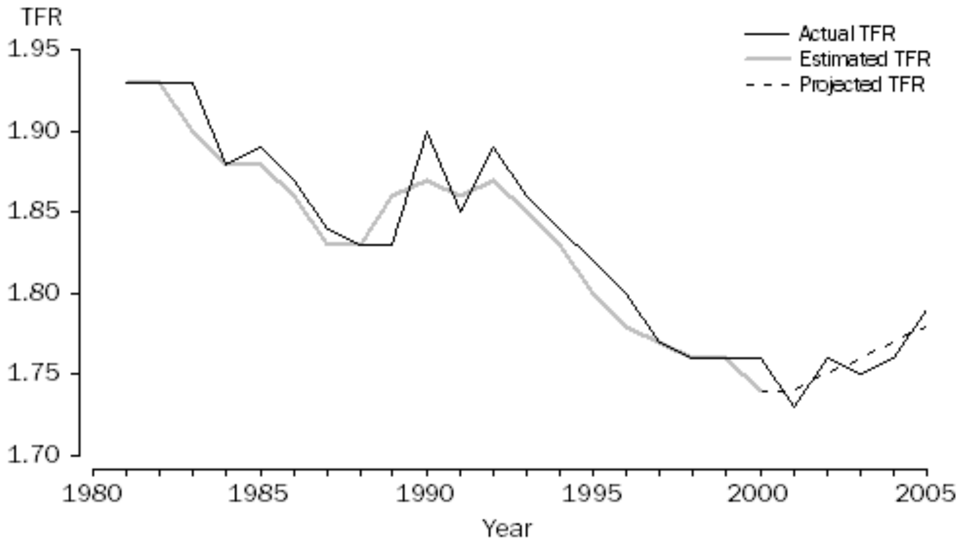


Figure 7: Actual, Estimated and Projected Total Fertility Rates, Australia **-** 1980 to 2006



Footnotes

1 - Director, Australian Demographic and Social Research Institute, The Australian National University <back

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Explanatory Notes

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Rallu, J-L. and Toulemon, L. 1994. 'Period fertility measures: the construction of different indices and their application to France, 1946-89'. **Population: An English Selection** 6: 59-93.

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Glossary

GLOSSARY

Age-specific fertility rates

Age-specific fertility rates (ASFR) are the number of live births (occurred or registered) during the calendar year, according to the age of the mother, per 1,000 of the female estimated resident population of the same age at 30 June. For calculating these rates, births to mothers under 15 years are included in the 15-19 years age group, and births to mothers aged 50 years and over are included in the 45-49 years age group. Pro rata adjustment is made for births for which the age of the mother is not given.

Baby boom

Baby boom refers to the generation born between the end of World War II and the mid-1960s. Baby boomers are usually taken to be those born in the years 1946 to 1965 inclusive.

Birth

The delivery of a child, irrespective of the duration of pregnancy, who, after being born, breathes or shows any evidence of life such as a heartbeat.

Childbearing ages

See Reproductive lifetime.

Completed cohort fertility rate

The average number of live births that a woman born in a particular year has had by the end of

her reproductive life.

Multiple birth

A multiple birth is a confinement which results in two or more children, at least one of which is live-born.

Parity

Parity refers to the number of live births a woman has had previous to the most recent birth. Parity is also an attribute of any live birth, being the order of that birth (e.g. first birth, second birth, and so on) of a woman.

Parity-age-duration total fertility rate

The sum of age-parity-duration specific fertility rates. This measure of fertility takes into account age of mother, parity and duration since previous birth.

Previous births

Previous births refer to children born alive (who may or may not be living) to a mother prior to the registration of the current birth in the processing period. In some states, legitimised and legally adopted children may also be included.

Due to variation in data collection and processing methods across states and territories, different definitions of the concept of previous births have been applied.

Changes in ABS processing of data collected by state/territory Registrars of Births, Deaths and Marriages for 2007 have resulted in the availability of improved information on previous births to mothers. Prior to 2007, ABS published information on previous births of the mother from the **current** relationship only, for all states and territories. From 2007, data on previous births for **all** relationships (both current and previous, if any) of the mother are collected for all states and territories, excluding Victoria and Queensland.

Previous children

See Previous births.

Reproductive lifetime

Women's childbearing years, usually assumed as the ages from 15 to 49 years for the purpose of analysis. In this publication, births to women less than 15 years are included in the 15 years age group and those 50 years and older are included in the 49 years age group.

Tempo standardised period total fertility rate

A measure which removes the effects of timing changes from the trend in the total fertility rate.

Total fertility rate

The sum of age-specific fertility rates (live births at each age of mother per female population of that age). It represents the number of children a female would bear during her lifetime if she experienced current age-specific fertility rates at each age of her reproductive life.

Abbreviations

ABBREVIATIONS

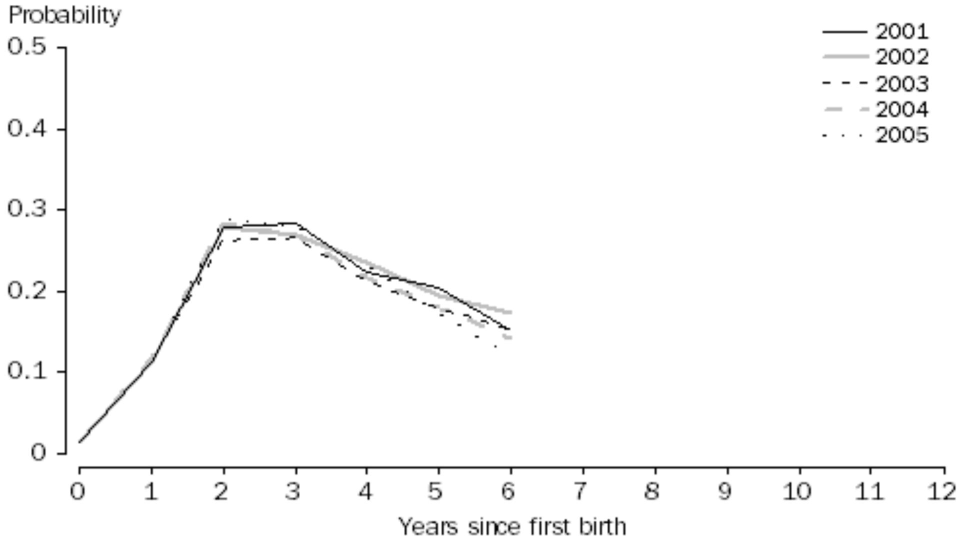
ABS	Australian Bureau of Statistics
ACAP	Australian Census Analytic Program
ASFR	age-specific fertility rate
cat. no.	catalogue number
CCFR	completed cohort fertility rate
PADTFR	parity-age-duration total fertility rate
TFR	total fertility rate
TSPTFR	tempo standardised period total fertility rate

Appendix 1

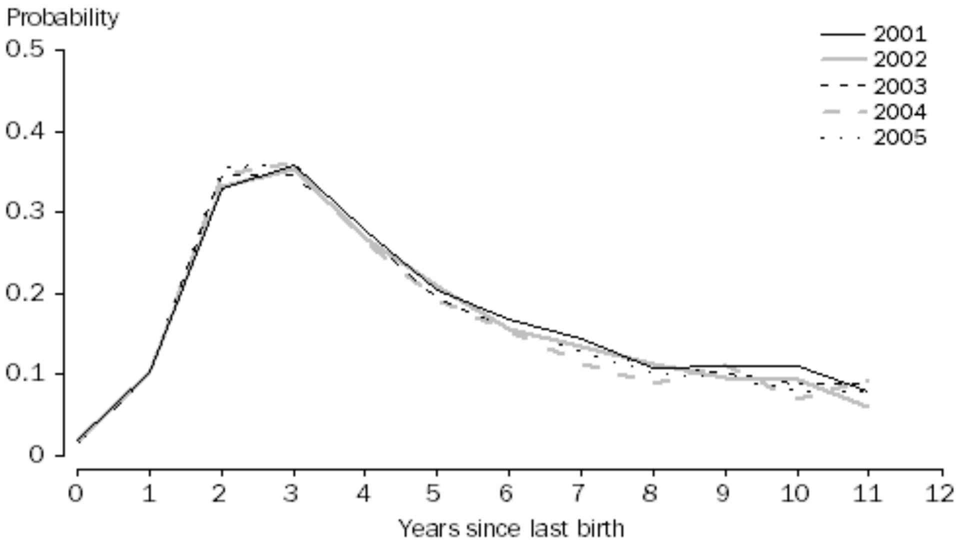
APPENDIX ONE

CHARTS OF AGE-PARITY-DURATION SPECIFIC BIRTH RATES, 2001 to 2005

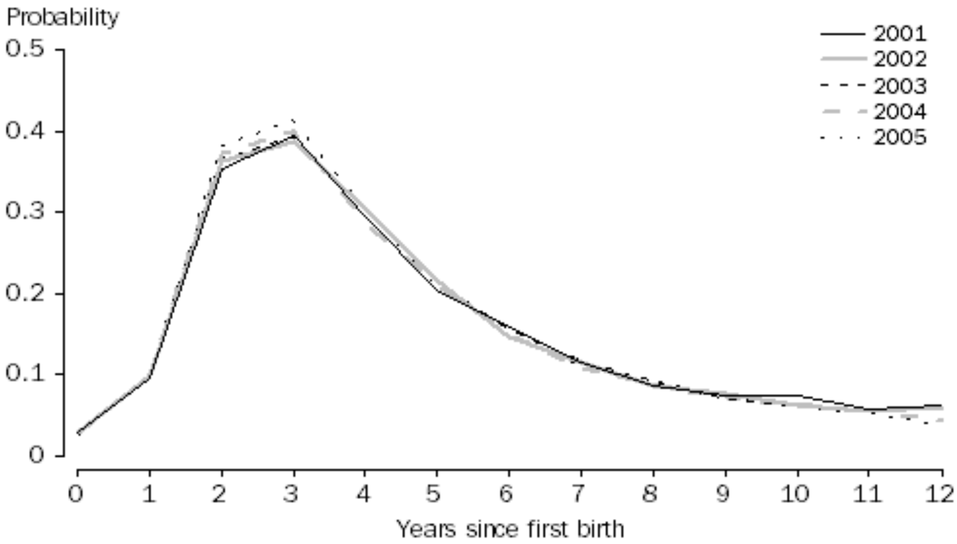
A.1 Probability of having a second birth by duration since first birth,
Women aged 20-24 years at first birth, 2001 to 2005



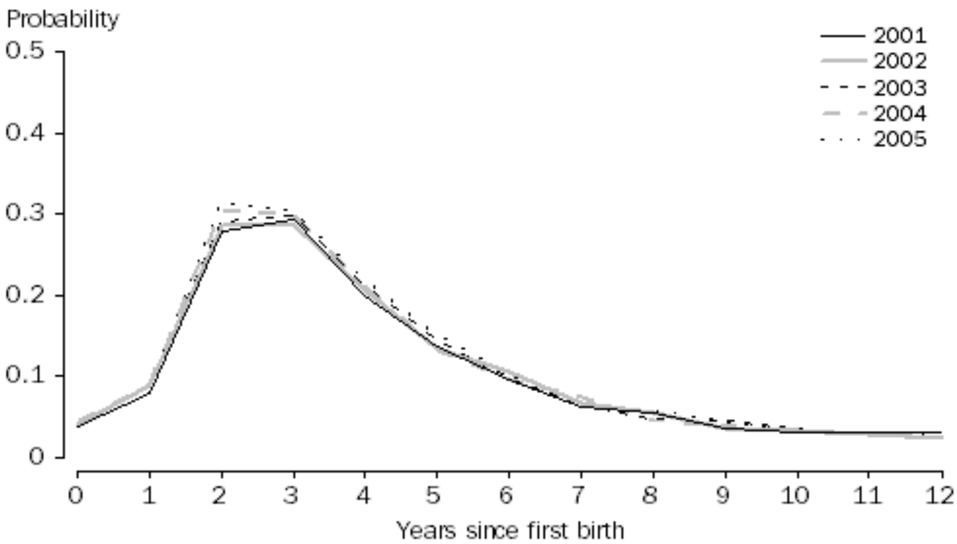
A.2 Probability of having a second birth by duration since first birth,
Women aged 25-29 years at first birth, 2001 to 2005



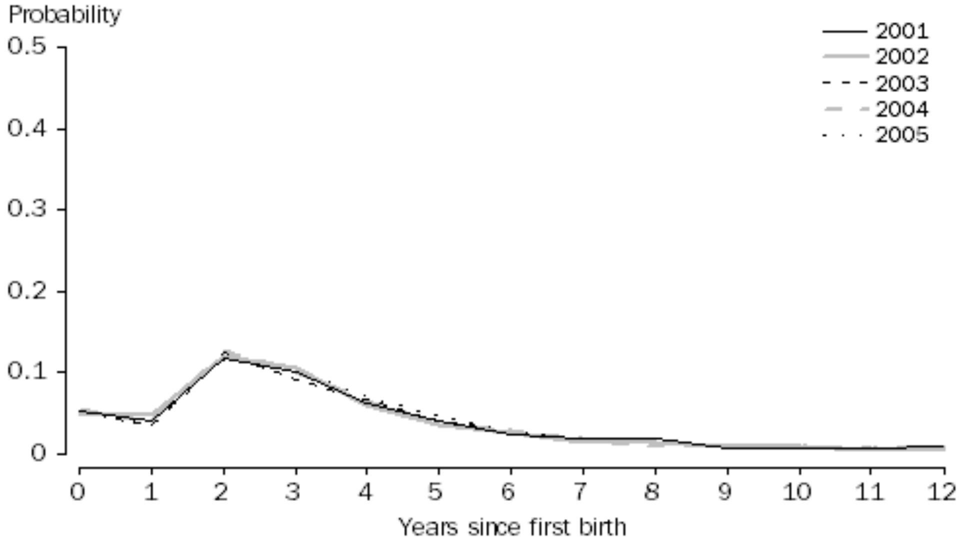
A.3 Probability of having a second birth by duration since first birth,
Women aged 30-34 years at first birth, 2001 to 2005



A.4 Probability of having a second birth by duration since first birth,
Women aged 35-39 years at first birth, 2001 to 2005



A.5 Probability of having a second birth by duration since first birth,
Women aged 40-44 years at first birth, 2001 to 2005



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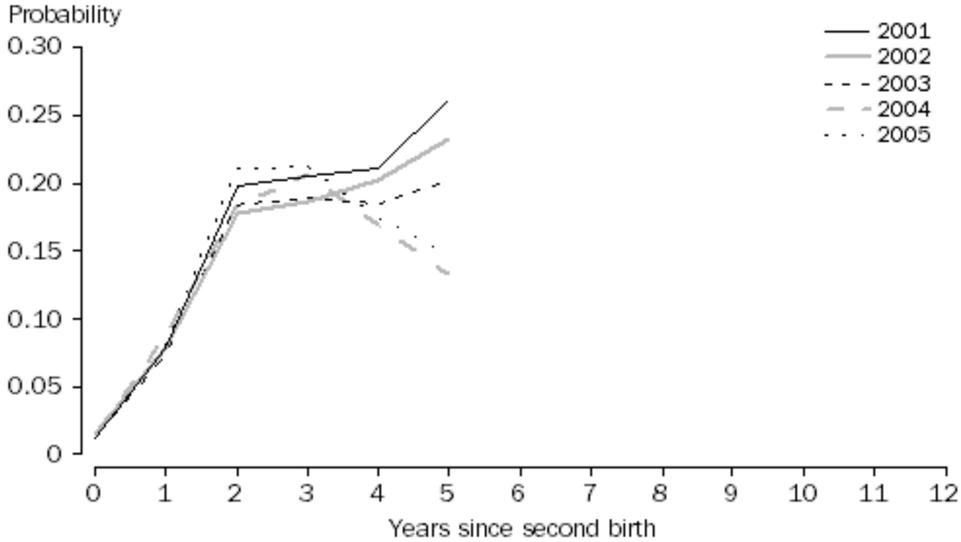
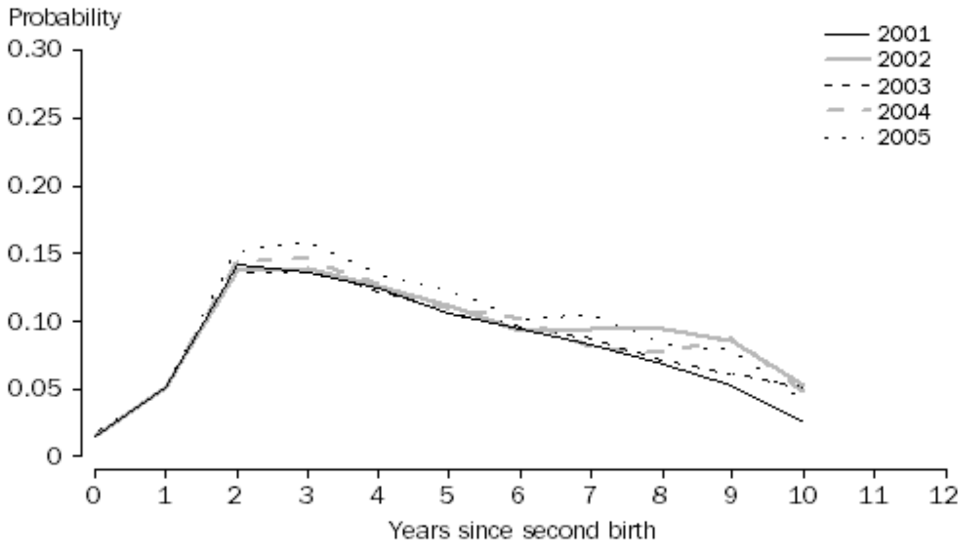
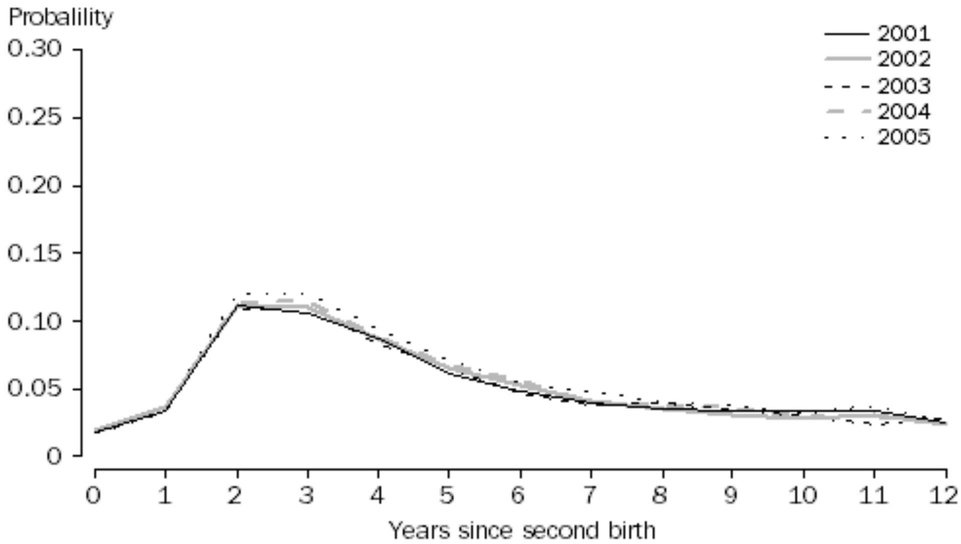
A.6 Probability of having a third birth by duration since second birth,
Women aged 20-24 years at second birth, 2001 to 2005



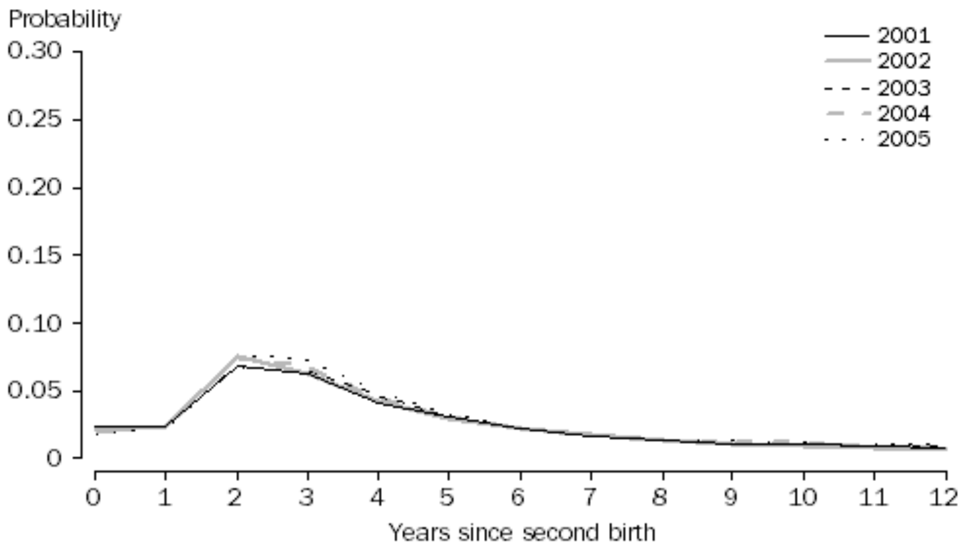
A.7 Probability of having a third birth by duration since second birth,
Women aged 25-29 years at second birth, 2001 to 2005



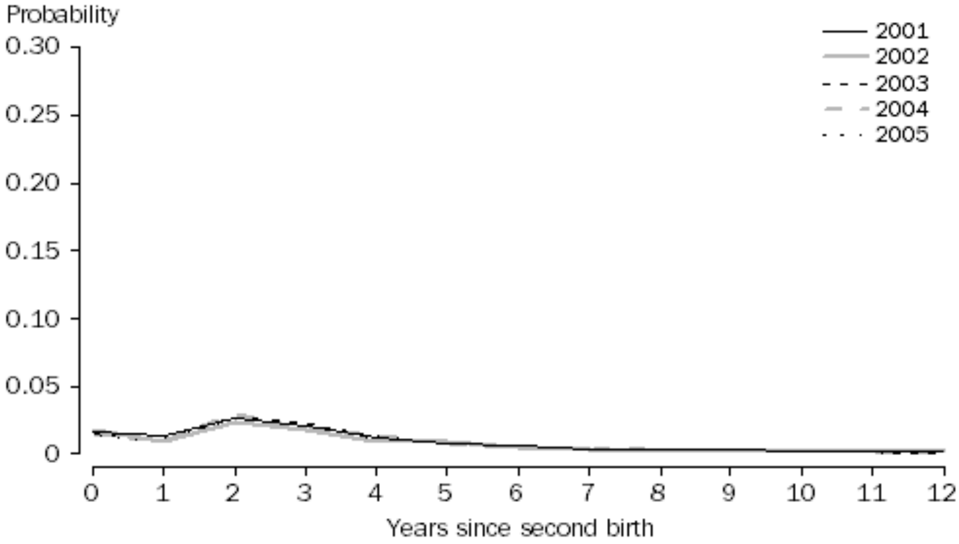
A.8 Probability of having a third birth by duration since second birth,
Women aged 30-34 years at second birth, 2001 to 2005



A.9 Probability of having a third birth by duration since second birth,
Women aged 35-39 years at second birth, 2001 to 2005



A.10 Probability of having a third birth by duration since second birth,
Women aged 40-44 years at second birth, 2001 to 2005



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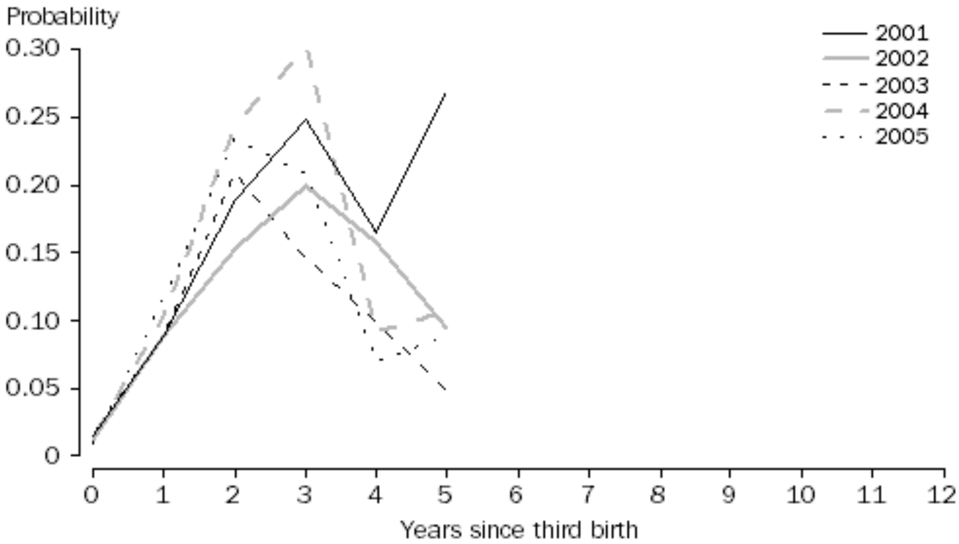
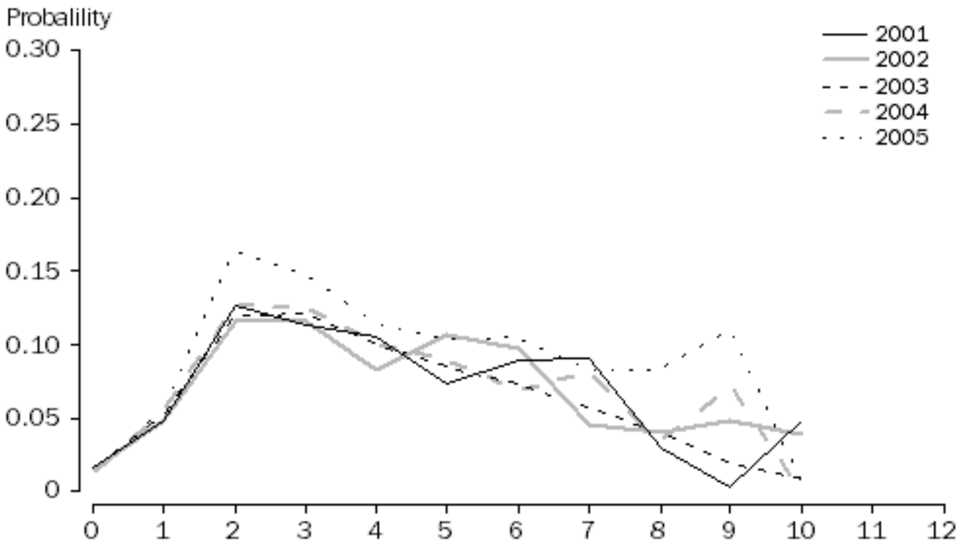
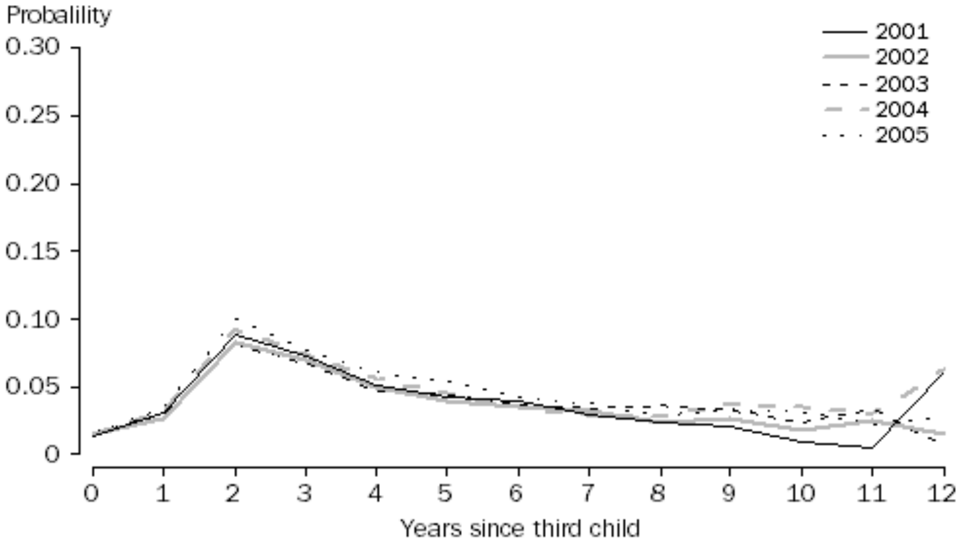
A.11 Probability of having a fourth birth by duration since third birth,
Women aged 20-24 years at third birth, 2001 to 2005



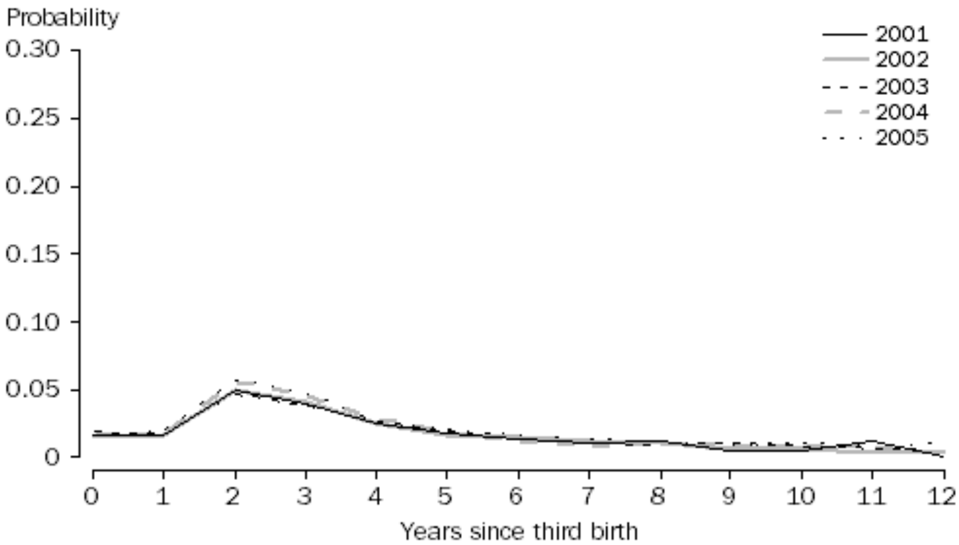
A.12 Probability of having a fourth birth by duration since third birth,
Women aged 25-29 years at third birth, 2001 to 2005



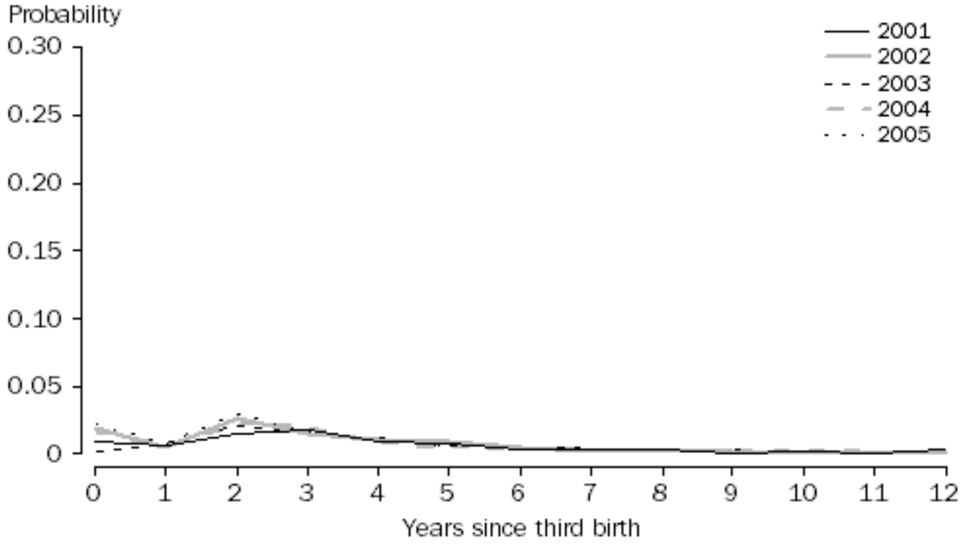
A.13 Probability of having a fourth birth by duration since third birth,
Women aged 30-34 years at third birth, 2001 to 2005



A.14 Probability of having a fourth birth by duration since third birth,
Women aged 35-39 years at third birth, 2001 to 2005



A.15 Probability of having a fourth birth by duration since third birth,
Women aged 40-44 years at third birth, 2001 to 2005



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Appendix 2

APPENDIX TWO

USING CENSUS DATA TO CREATE A DETAILED DATABASE FOR FERTILITY ANALYSIS

Data for this research are derived from complete counts from the 1981, 1986, 1991, 1996, 2001 and 2006 Australian Censuses of Population and Housing. For each Census, Australian-resident women in each household are matched to their children living in the same household at the time of the Census. This is done using the 'relationship in the household' Census variable(1) , which describes the relationship of each person in the household to the household reference person (generally Person 1 or Person 2 on the census household form).

Available characteristics from these data are age of woman, number of own children in the household aged under 20 years, and age of each of these children at the time of each Census(2) . These data are used to construct distributions of women by single year of age, by number of own children, by age of youngest child in single years (time since last birth), for each year 1980—2006.

For example, the distribution for 2006 is calculated by tabulating women by age, by number of own children, by age of youngest child, from the 2006 Census count. The distribution for 2005 is calculated by subtracting one year from the age of each woman in 2006, adjusting down the number of her own children if she had a child aged zero years at the 2006 Census, and adjusting the age of youngest child, and so on back to 2001. The process is repeated for the other censuses.

This 'reverse survival' results in six sets of annual distributions: 1980—81, 1981—86, 1986—91, 1991—96, 1996—2001 and 2001—2006. These give an annual snapshot of the age/number-of-own-children/age-of-youngest-child status of each woman. Within each of the six sets, these data are used to calculate the probability that a woman aged *x* in year *y* with *j* own children, the *j* th born *i* years ago, transitioned to *j* +1 children in ageing to *x* +1 years in year *y* +1.

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The transition probabilities are calculated as follows:

$$q_{x,y,j,i+1} = 1 - \frac{P_{x+1,y+1,j,i+1}}{P_{x,y,j,i}},$$

$$0 \le j \le 4,$$
$$15 \le x \le 49,$$
$$1980 \le y \le 2005,$$
$$0 \le i \le 14 to 18$$

[1]

where $q_{x,y,j,i+1}$ is the probability that a woman aged x in year y of parity j with her j th birth i years ago progresses to birth j +1 in ageing from x years in year y to x +1 years in year y +1, and $P_{x,y,j,i}$ is the number of women aged x in year y of parity j with the j th birth i years ago. These probabilities are calculated as [1 - (probability that a woman does not progress to another birth)]**.**

An additional calculation is required for transition probabilities where the interval between births is zero years. These cases will appear in the Census data as two (or more) own children of the same age, and will usually occur for multiple births. For example, consider the case of a woman in 2006 aged 26 years with three own children, aged five, zero and zero years. In 2005 she will appear in the data as 25 years old, parity one, four years since last birth. In 2006 she will have shifted to 26 years old, parity three, 0 years since last birth. Her transition to second birth is captured by equation [1], but her transition to third birth is not. The latter transition is captured by considering the difference between the number of 'expected' and 'observed' women in each age/parity group in each year.

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The expected number of women, age x +1, year y +1, parity j +1, is given by:

$$Expected = \sum_{i=0}^{\omega} P_{x,y,j+1,i} + \left[\sum_{i=0}^{\omega} P_{x,y,j,i} - \sum_{i=1}^{\omega} P_{x+1,y+1,j,i} \right] - \left[\sum_{i=0}^{\omega} P_{x,y,j+1,i} - \sum_{i=1}^{\omega} P_{x+1,y+1,j+1,i} \right]$$

[2]

that is, the number of women age x in year y of parity j +1, plus the number of women age x in year y of parity j who have another birth in transitioning to age x +1 in year y +1, less the number of women age x in year y of parity j +1 who have another birth in transitioning to age x +1 in year y +1. This equation simplifies to:

$$Expected = \sum_{i=0}^{\omega} P_{x,y,j,i} - \sum_{i=1}^{\omega} P_{x+1,y+1,j,i} + \sum_{i=1}^{\omega} P_{x+1,y+1,j+1,i}$$

[3]

The observed number of women, age x +1, year y +1, parity j +1, is given by:

$$Observed = \sum_{i=0}^{\omega} P_{x+1,y+1,j+1,i}$$

[4]

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For women age *x* in year *y* with parity zero who transition to parity two in ageing to *x* +1, *y* +1, the number of their second births is given by [3] - [4], where *j* = 0:

2nd births with interval 0

$$= B_{x,y,2,0}$$

$$= Expected - Observed = P_{x,y,0} - P_{x+1,y+1,0} + \sum_{i=1}^{\omega} P_{x+1,y+1,1,i} - \sum_{i=0}^{\omega} P_{x+1,y+1,1,i}$$

[5]

For women who transition from parity *j*, *j* ≥ 1, to parity *j* + 2 in the course of one year, the number of their *j* + 2 births is given by:

[*j* + 2] births with interval 0

$$= B_{x,y,j+2,0}$$

$$= \sum_{i=0}^{\omega} P_{x,y,j,i} - \sum_{i=1}^{\omega} P_{x+1,y+1,j,i} + \sum_{i=1}^{\omega} P_{x+1,y+1,j+1,i} - \sum_{i=0}^{\omega} P_{x+1,y+1,j+1,i} + B_{x,y,j+1,0}$$

[6]

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The probability that a woman aged *x* in year *y* of parity *j* who transitions to parity *j* +1 in ageing to *x* +1, *y* +1, also transitions to parity *j* +2 in the same year is given by:

$$q_{x,y,j+1,0} = \frac{B_{x,y,j+2,0}}{\sum_{i=0}^{\omega} P_{x,y,j,i} - \sum_{i=1}^{\omega} P_{x+1,y+1,j,i}}$$

[7]

In the discussion above, the number of own children in the household has been equated with parity. However, the two are not necessarily equal, since children may have died or be resident outside the maternal home.

The transition probabilities calculated above were adjusted so that they refer to true parity rather than to own children. This was done by comparing the own-children transition probabilities for each year 1991—2000 to the parity transition probabilities for 1991—2000 calculated previously by Kippen (2003, 2004). We find that the ratio of transition probabilities for each age of woman and own children/parity is relatively constant across the ten years. We therefore use ratios averaged across the decade to inflate the own-children transition

probabilities to parity transition probabilities.

The 1981, 1986, 1996 and 2006 Censuses asked the number of children each woman had ever had. This information on number of children ever born(3) (parity) was used to restrict the distributions $P_{x,\,j,\,j,\,i}$ to women whose number of own children in the household was equal to their parity in the relevant Censuses for comparison.

We found that there was no need to adjust birth intervals to take account of children missing from the household. A comparison of interval distributions for all women, and women for whom number of children is equal to parity, showed that they are virtually identical. This suggests that if mothers have children missing from their household, it is likely that all their children are missing, or that the oldest or youngest are missing.

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Footnotes

1 - There are limitations to using the relationship in household variable to identify natural mother-child relationships in a household. The identification of a 'child' to a female reference person does not imply that the child is born of that mother. A parent-child relationship is defined in the Census as "a relationship between two persons usually resident in the same household. The nominal child is attached to the nominal parent via a natural, adoptive, step, foster or child dependency relationship." While in later Censuses it is possible to separately identify the relationships of 'step', 'foster' or 'other dependent' in the parent-child relationship, it has never been possible to distinguish between 'natural' and 'adoptive' parent-child relationships across the Censuses using the relationship in household variable. <back

2 - It should be noted that there are known data quality issues related to the reporting of 'age' and these may impact the data and analysis. For further information please read the data quality statements included in 2006 Census of Population and Housing - Reference and Information. <back

3 - It should be noted that there are known data quality issues related to the reporting of 'number of children ever born' and these may impact on the data and analysis. For further information please read the data quality statements included in 2006 Census of Population and Housing - Reference and Information. <back

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